

28.

Young *Megalops cyprinoides* from Batavia, Dutch East India,
Including a Study of the Caudal Skeleton and a Comparison
with the Atlantic Species, *Tarpon atlanticus*.¹

GLORIA HOLLISTER

(Text-figures 1-21).

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INTRODUCTION.

Dr. C. Holstvoogd of the Laboratorium Voor Het Onderzoek Der Zee, Batavia, Dutch East India, in a letter dated September 28, 1937, urgently requested specimens of *Albula vulpes* in order to complete his study on the kidneys of teleost fishes. The substance of this letter reads: "To check and complete the results of my investigations on the kidneys of the teleosts, I should very much like to have at my disposal some material of *Albula*. I have written to three Zoological stations in the United States and to one in Mexico, but in vain. In each case I was informed that the material required by me was not present and was not to be caught either, or only with too much trouble and expense. As regards the publication 'Caudal Skeleton of Bermuda Shallow Water Fishes' in *Zoologica*, Vol. XXI, part 4, I apply to you with more hope. Only 4 specimens would be sufficient. In my turn I am able to place at your disposal material of *Megalops* which is rather rare in the neighbourhood of Bermuda as I read in the above mentioned publication. If you agree to it I shall publish my results in *Treubia* together with those about the kidneys of *Elops* and *Megalops*, but if you insist upon it I'm also willing to publish the part which specially deals with *Albula* in *Zoologica*."

Consequently five specimens of *Albula vulpes*, collected in Bermuda at the field station, Nonsuch, were sent to Dr. Holstvoogd. Four of these were in the leptocephalus stage and ranged from 26 mm. to 40 mm. One specimen was a young fish of 55 mm. in length.

¹ Contribution No. 586, Department of Tropical Research, New York Zoological Society. Contribution from the Bermuda Biological Station for Research, Inc.

On March 22, 1939, a small package arrived from Dr. Holstvoogd, Batavia, and contained 45 specimens of young *Megalops cyprinoides*. The oldest, which is 34 mm. in length, is a miniature of its parent. The youngest, in the leptocephalus form, is 21 mm. long. On October 13, 1939, five more specimens in leptocephalus stage were received from Dr. Holstvoogd which he writes are "the youngest and consequently longest I have seen to date." These fish measure 22 mm. to 24 mm. and were preserved in Bouin's fluid and then Cedar Oil. This forms a most complete series of young *Megalops* and shows the changes which occur when the young stage becomes compact and shrinks while developing into a small fish. We are very much indebted to Dr. Holstvoogd for these valuable specimens.

We have been fortunate in observing this same transformation in a *living* isospondyliid. After catching a leptocephalus *Albula vulpes* off the wharf at Nonsuch, Bermuda, we reared it for ten days. It was 55 mm. in length on the night of capture and during the ten days it shrank to 20 mm. in length and came to resemble the adult in form.²

The length of specimens in this paper is standard length unless otherwise stated.

For caudal fin terminology, key to caudal fin of Bermuda shallow water Isospondyli including *Tarpon*, complete caudal bibliography, and method of preparing cleared specimens for this study, refer to Part I of Caudal Skeleton of Bermuda Fishes, Hollister, 1936.2.

We take this opportunity to thank staff members of the United States National Museum for putting at our disposal the collection of *Megalops cyprinoides*, the loan of two *Megalops cyprinoides* and one *Tarpon atlanticus*. We are indebted to Dr. C. M. Breder, Jr. for 4 small *Tarpon* caught August, 1939, at Sanibel Island, Florida. These specimens came to the New York Aquarium with forty-odd others for exhibition. The cooperation of Dr. William Beebe, Director of this department, and Mr. John Tee-Van, General Associate, is gratefully acknowledged.

All the drawings are by Miss Harriet Bennett, with the exception of two (Text-figs. 2, 21), which are by Mr. George Swanson.

TAXONOMIC DISCUSSION.

(Text-fig. 1).

Tate Regan in "A revision of the fishes of the genus *Elops*"³ bases this revision principally on vertebral counts. It is also notable that the species with different counts live in different geographical areas. But Regan did not consider these characters and other differences sufficient to establish a new genus for any of the species of *Elops*.

Megalops cyprinoides is the type of its genus and the Pacific and Indian Ocean species. A closely related form lives in the Atlantic and was first described as *Megalops atlanticus*.⁴ This latter form was later renamed *Tarpon* by Jordan & Evermann.⁵ Their reason for this was: "The posterior insertion of the dorsal fin distinguishes the single species of *Tarpon* from the East Indian *Megalops cyprinoides*, a fish of similar habit, in which the dorsal is inserted above the ventrals."

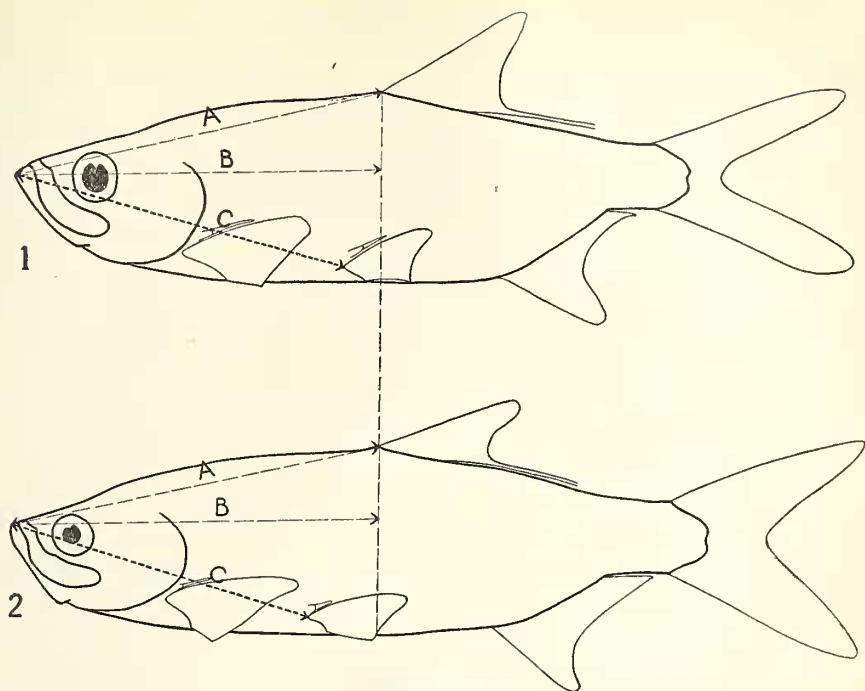
This particular character is not a valid one. A comparative study has been made of nine *Megalops cyprinoides* which range in size from 20 mm. to 300 mm., together with twenty-seven specimens in the collection of the United States National Museum at Washington. These have been compared with ten *Tarpon atlanticus* ranging from 51 to 238 mm. It is apparent that the dorsal fin is in the same position in the two species, that is, in the

² Hollister, 1936.1.

³ Regan, 1909.

⁴ Cuvier & Valenciennes, 1846.

⁵ Jordan & Evermann, 1896.



Text-figure 1.

In outline 1, of *Megalops cyprinoides*, the distance represented by line C is longer than the distance represented by line C in outline 2 of *Tarpon atlanticus*. The position of the ventrals is farther from the tip of the snout in *Megalops* than in *Tarpon*. Lines A and lines B are equal in *Megalops* and *Tarpon*, showing that the position of the dorsal fins is identical in the two species.

same relative distance from the snout. But the ventral fins in *Tarpon* are nearer the snout than in *Megalops*, giving the illusion of the dorsal being more posterior in position in *Tarpon* than in *Megalops*. According to actual measurements, Jordan & Evermann's character for describing a new genus must have been based on appearance instead of measurements (Text-fig. 1).

As in the case of *Elops*, there are other differences in addition to the position of the ventral fins. These include considerable variation in the vertebral counts of the Atlantic and Pacific species, *Tarpon* having 57 and *Megalops* 68. Some other differences are: dorsal fin counts, *Tarpon* having 12 to 15 rays and *Megalops* 19 to 21; anal fin counts, *Tarpon* having 19 to 22 rays and *Megalops* 24 to 27. Caudal skeleton variations are shown in the key and the text. In general appearance *Tarpon* is more slender than *Megalops* and the eye of *Tarpon* is not as large as the eye of *Megalops*. Regan (1910) found a difference in the dorsal caudal rays of the two species.

In view of these differences and of the disconnected geographical ranges, the two forms should be kept apart in their respective genera.

The word *Tarpon* is probably of American Indian origin with its exact meaning still uncertain. It occurs in early descriptions of travels in Florida by Captain William Dampier in his "Second Voyage to the Bay of Campeche," 1675, and published in Masfield's Edition of his works. In the West Indies and in South America this splendid fish has many other popular and native names.

YOUNG *Megalops* AND YOUNG *Tarpon*.

(Text-figs. 2 & 3).

An excellent start has been made by Dr. Charles Breder⁶, of the Society's New York Aquarium, at the recently established field station on Palmetto Key on the west coast of Florida. Here important initial and tedious work is being carried on systematically, that of tagging *Tarpon* in order to try to solve the fascinating mystery of their spawning habits.

There has been considerable conjecture concerning where the eggs are deposited, whether or not they float or sink, whether the larvae live on the surface and where they exist until they grow to be about three inches long. According to numerous reports, many three-inch *Tarpon* can be found⁶. But only twice, previous to Dr. Breder's recent catch⁷, have *Tarpon* been reported which are smaller than three inches.⁸ One specimen has no description and cannot be located⁹. The other small specimen is described by Dr. Hildebrand¹⁰, Ichthyologist of the U. S. Bureau of Fisheries, who has shown that the American *Tarpon* presumably passes through a leptocephalus stage. This small *Tarpon* of 20 mm. in length was in the transitional post-larval stage and compares approximately to Text-fig. 7, on page 457, of *Megalops cyprinoides*.

Economic necessity of the coastal people has brought to ichthyologists of Batavia, Java, knowledge of the young *Megalops*. Here larvae have been had in numbers ever since Kampen¹¹ first recognized the leptocephalus stage in 1908. In the month of January, fish larvae appear in the brackish water of the harbor canals of Batavia. The total length of the larvae collected varies from 23 to 30 mm. and all appear to be in the same stage of development. Kampen stated that older stages have not yet been found, and the development of the larvae is unknown. Later Dr. Holstvoogd¹² tells of the young appearing on the coast near Tegal, 400 kilometers from Batavia, and standing the journey to Batavia by train and being raised in aquaria and gradually being moved into fresh water. They were reared on mosquito larvae and fresh water copepods. Their length when appearing on the coast averages a little more than 23 mm. Dr. Holstvoogd states that "in the case of our breeding experiment this took seven weeks. During this time the young *Megalops* shrink from 23 to 17 mm. and then grow to about 24 mm."

Near relatives of *Megalops* and *Tarpon*, such as *Albula* and *Elops*, are known to pass through a leptocephalus metamorphosis and they are also known to be oviparous. From all evidence it is now almost certain that our Atlantic *Tarpon* is comparable in its early metamorphosis with the Pacific species, *Megalops cyprinoides*. (These facts should certainly dismiss the idea of *Tarpon* being viviparous according to observations of an experienced *Tarpon* fisherman, the short account of which is published on page 54 in the *Bulletin* of the New York Zoological Society, Vol. XXXI, No. 2, March-April, 1928).

The observation of the growth of our *Albula vulpes* leptocephalus gives us some clue to the rapidity of this transformation. In ten days this leptocephalus shrank from 55 mm. to 20 mm., when it resembled the adult (Text-fig. 2). Dr. Holstvoogd does not mention the exact time it took his leptocephalus *Megalops* to go through the shrinking phase but in our *Albula* this was very rapid. But he does state that the complete change took seven weeks for *Megalops* to shrink from 23 mm. to 17 mm. and then grow to 24 mm. It is conspicuous that the larvae of *Megalops* are not as long as those of *Albula* in the same stage of development (Text-fig. 3).

⁶ Breder, 1939.1.

⁷ Breder, 1939.2.

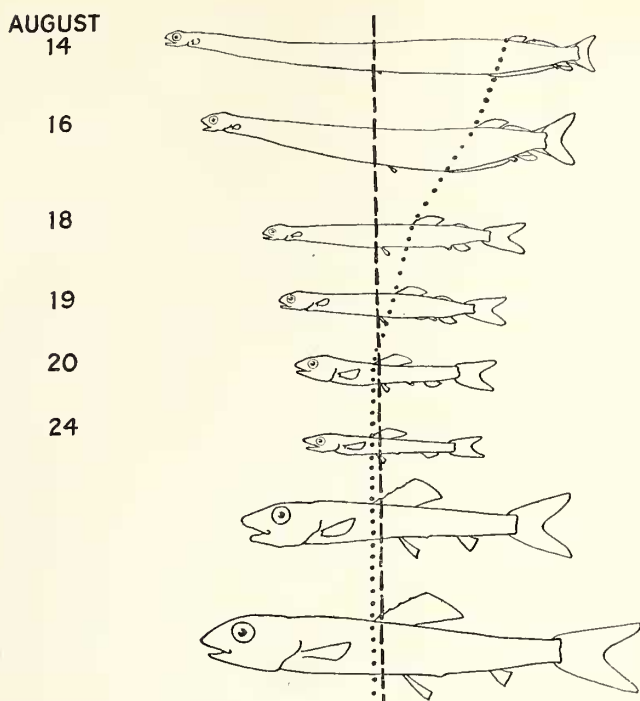
⁸ See Sections IV and V in Bibliography.

⁹ Eigenmann, 1904.

¹⁰ Hildebrand, 1934.

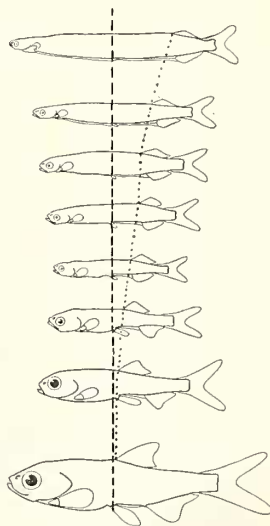
¹¹ Kampen, 1909.

¹² Holstvoogd, 1936.



Text-figure 2.

Albula vulpes. This series is reproduced to show the development from the leptocephalus stage to the young fish which is comparable with *Megalops*. During ten days the 55 mm. leptocephalus *Albula*, shown at the top, shrank to 20 mm., when it resembled the adult. The observation of the transformation in a living isospondylid gives a clue to the rapidity of this change. (Natural size).



Text-figure 3.

Megalops cyprinoides. This series shows the development from the leptocephalus stage to the young fish. The leptocephalid *Megalops* at the top is from Kampen and 26.5 mm. long. As in *Albula*, the length diminishes during the transformation and the posterior position of the dorsal changes to a forward position at the mid-length on the dorsal surface. The larvae of *Megalops* are not as long as the larvae of *Albula* in the same stage of development. (Natural size).

Fish having the demersal type of eggs, or possessing some form of parental care, usually produce a much smaller number of eggs. It is also known that fish having the pelagic type of eggs produce the highest number. *Elops* is a good example, with an estimated number of about five million eggs and Cod have been estimated to have a maximum number of nine million eggs.

In regard to *Tarpon* eggs, Dr. John Nichols estimated the number and size of the eggs in a 142-pound *Tarpon*¹³ at twelve million. The eggs were non-adhesive, unripe and exceedingly small. Dr. Nichols found that they ranged from 0.6 to 0.75 mm. in diameter. Recently, Dr. Breder¹⁴ published a photograph of an egg, which "may be that of a *Tarpon*," and measured "not quite 2 mm. in diameter." The eggs from the 142-pound *Tarpon* were unripe and preserved whereas the egg of Dr. Breder was fresh and alive. It was also non-adhesive and found on the bottom. Mr. Babcock discovered through repeated experiments that *Tarpon* eggs sink and he also tells of a reliable and experienced fisherman who reports that he has seen *Tarpon* spawning in white sand holes along the shoals.

The habit of *Tarpon* of breaking the surface of the water and its ability to acquire air this way no doubt accounts for the fact that *Tarpon* can exist for long periods of time in pools of stagnant and foul water. The handsome *Tarpon* living in the New York Aquarium can be seen breaking the surface for air. *Leptocephalus Megalops cyprinoides* regularly rise to the surface for air according to Beaufort¹⁵ and also Delsman & Hardenberg¹⁶. In *Megalops* larvae the air bladder is well developed in the youngest larvae, which are caught on the surface as they work their way in toward fresh water. According to literature and also experiments at Nonsuch, our field station in Bermuda¹⁷, a number of species can adapt to salt or fresh water and during the life development of certain species this change is vital. The smallest recorded *Tarpon* have been found away from the sea¹⁸.

DESCRIPTION AND FIGURES OF *Megalops cyprinoides*, INCLUDING A
COMPARISON WITH *Tarpon atlanticus*.

(Text-figs. 4-13).

Range.

The map shows that *Megalops* and *Tarpon* are circumtropical with world-wide distribution (Text-fig. 4). References indicate that the northern and southern range is roughly between 40° north latitude and 40° south latitude.

A geographical section of the bibliography was not arranged for *Megalops* because the habitats of this species are well established. References included in the annotated bibliography show that *Megalops* is found from about the region of the island of Formosa, south along the coast of China, around the islands of the East Indies and Polynesia and along the coast of Australia as far south as New South Wales. *Megalops* is recorded off the coast of India and the islands of the Indian Ocean, and also along the east coast of Africa as far south as Durban. The reported eastern range is the Society Islands in the Pacific.

We are finding that *Tarpon* has a more extensive range than has been generally recognized in American literature and because of this the repeated statement of "Cape Cod to Brazil" should be revised. The northernmost record, Nova Scotia, is considered rare and the specimen a straggler. In

¹³ Nichols, 1929.

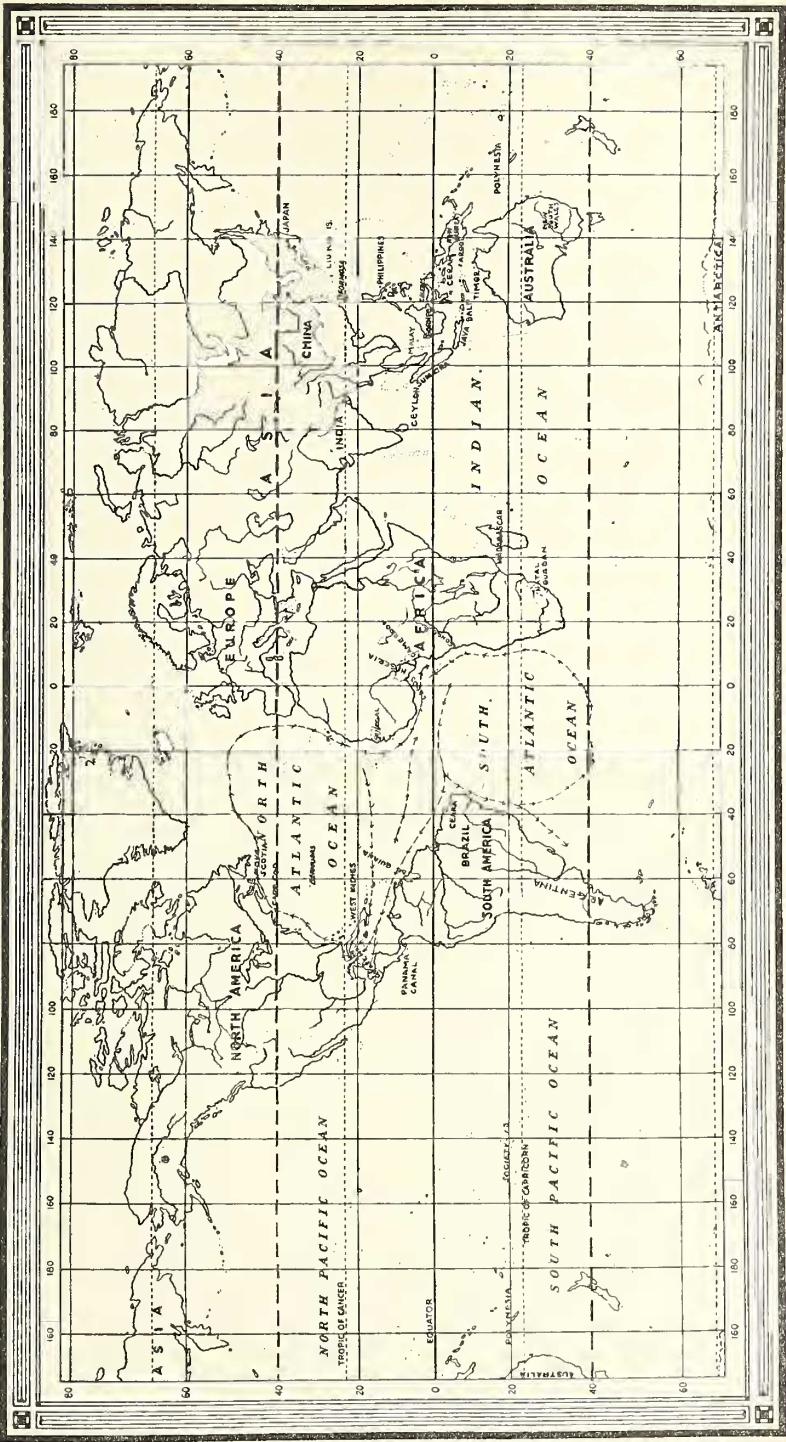
¹⁴ Breder, 1939.2.

¹⁵ Beaufort, 1909.

¹⁶ Delsman and Hardenberg, 1934.

¹⁷ Hollister, 1934.

¹⁸ See Section IV and V in Bibliography.



Text-figure 4.

References indicate that *Megalops* and *Tarpon* are circumtropical with world-wide distribution and that the northern and southern range is approximately between 40° north latitude and 40° south latitude, which is shown by the heavy dashed lines. For *Tarpon* the extreme locations are shown as Nova Scotia, Cape Cod, Bermuda, the Pacific side of the Panama Canal and the west coast of Africa. The Gulf Stream, Equatorial and Connecting Currents are indicated by the arrows. For *Megalops* the southernmost reference is Natal, Africa, and New South Wales, Australia and the most eastern the Society Island.

addition to the many records of *Tarpon* along the Atlantic and Gulf coasts, the West Indies and miles up rivers, there is now definite proof that *Tarpon* have reached the Pacific side of the Panama Canal. Also, *Tarpon* are known to inhabit the eastern Atlantic off the west coast of Africa. References have been found for *Tarpon* at Senegal and south to the Congo River. It is reported that many large *Tarpon* are in Lagos Harbour, Nigeria.

The extent of the Gulf Stream, the Equatorial and Connecting Currents, is indicated on the map (Text-fig. 4).

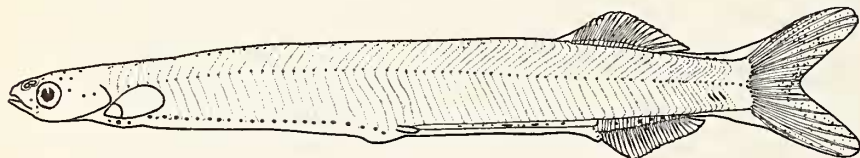
Material Studied.

Megalops cyprinoides: 50 young specimens, 24 mm. larva to 34 mm. fish, Batavia, Java, Cat. No. 28,900 and 28,903 (Text-figs. 5-8). 1 specimen, 56 mm., Philippine Isls., U. S. Nat. Mus. No. 51,970. 1 specimen, 300 mm., Queensland, Australia, U. S. Nat. Mus. No. 47,800 (Text-fig. 9). In addition, 22 specimens in the collection of the United States National Museum were examined for the position of the fins and the prolonged posterior dorsal ray.

Tarpon atlanticus: 4 specimens, 51, 55, 58 and 59 mm., Sanibel Island, Florida, Cat. No. 28,902. 1 specimen, 78 mm., Source Matelas, Haiti, Cat. No. 7,303 (Text-fig. 10). 3 specimens, 115, 140, 150 mm., Source Matelas, Haiti, Cat. No. 7,303. 1 specimen, 238 mm., West Indies, U. S. Nat. Mus. No. 33,347 (Text-fig. 11).

Megalops cyprinoides.

Four distinct stages in the transition from the leptocephalus form to a small fish resembling the adult have been selected to illustrate the metamorphosis in *Megalops cyprinoides* (Broussonet).

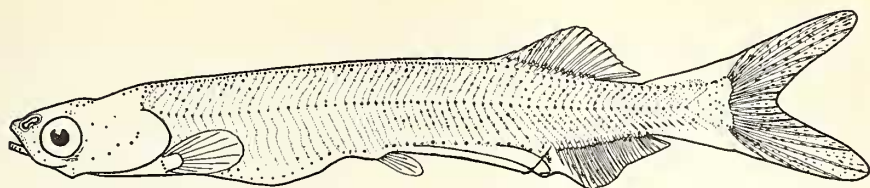


Text-figure 5.

Megalops cyprinoides. This 21 mm. leptocephalus is flat, band-like and almost transparent. The dorsal is posterior in position and the ventrals very small. ($\times 4.7$).

The 21 mm. specimen is flat, band-like and almost transparent. Definite pigmentation occurs only along the mid-line of the body, with one dark spot on every myomere, and between the pectorals and ventrals. The other scattered pigment spots are shown accurately in Text-fig. 5. There is a total of 67 myomeres, 45 from the head to the anterior of the dorsal fin and 27 from the head to the ventral fins. The rays of the paired fins cannot be distinguished and those of the median fins are visible but delicate. The pectorals are large and flap-like. The ventrals are very small and approximately midway between the snout and caudal. The dorsal fin is posterior in position and immediately anterior to the caudal peduncle. The intestine is visible between the ventral and the anal fins.

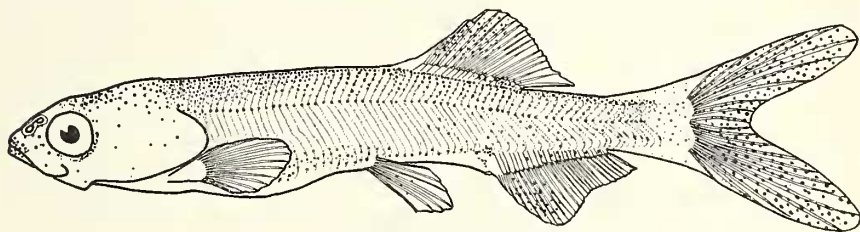
The 15 mm. specimen is the shortest transitional larva among our specimens. It is fairly flat but less band-like than the 21 mm. specimen and not as transparent. Definite pigmentation is along the mid-line as in the 21 mm. specimen. There is more pigmentation in this specimen with a noticeable increase along the dorsal side between the head and the dorsal fin. There is



Text-figure 6.

Megalops cyprinoides. This 15 mm. specimen is the shortest larva in our series and transitional in development. ($\times 6.3$).

also a general increase all over the body as illustrated in the accurate Text-fig. 6. There is a total of 65 myomeres; 40 from the head to the anterior of the dorsal fin and 23 from the head to the ventrals. There is a noticeable decrease, as compared with the 21 mm. specimen, in the number of the myomeres and the length of the body in these two regions. The rays of the paired fins are visible but delicate and those of the median fins are more definite than in the 21 mm. specimen. The pectorals are proportionately larger than in the 21 mm. specimen. The ventrals have greatly increased in size and are in the same position as in the 21 mm. fish. The dorsal fin is more anterior than in the 21 mm. fish and the caudal peduncle more elongated. The intestine is still visible between the ventral and the anal fins.

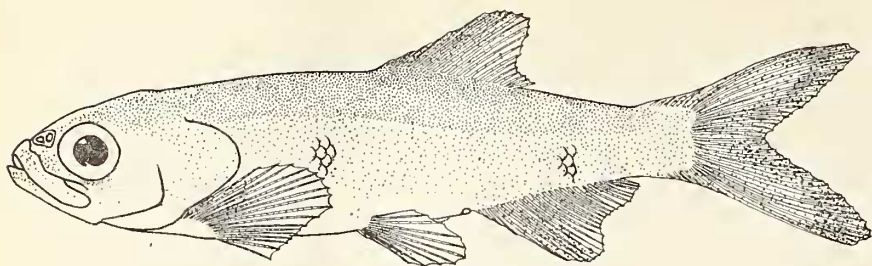


Text-figure 7.

Megalops cyprinoides. This 16.5 mm. specimen is post leptocephalus in development but has some characters of the younger stage. ($\times 5.5$).

The 16.5 mm. specimen is post-leptocephalus in development and the body has lost the flat, band-like appearance of the younger and longer specimens. But this stage possesses characters of the larval and older fish. The pigmentation along the mid-line is still conspicuous and there is a general increase over all of the body and the fins which is shown in the accurate Text-fig. 7. There is a total of 65 myomeres; 33 from the head to the anterior of the dorsal fin and 22 from the head to the ventrals. This count shows a continued decrease in number to the dorsal fin but less to the ventrals. The rays of the paired fins are definite and the fins are proportionately larger than in the 15 mm. specimen. The ventrals remain in the center position of the body. The median fins show considerable growth. The dorsal is more anterior in position than in the 15 mm. specimen and the distance is shorter between the pectorals and the anterior margin of the dorsal fin. The intestine is not visible.

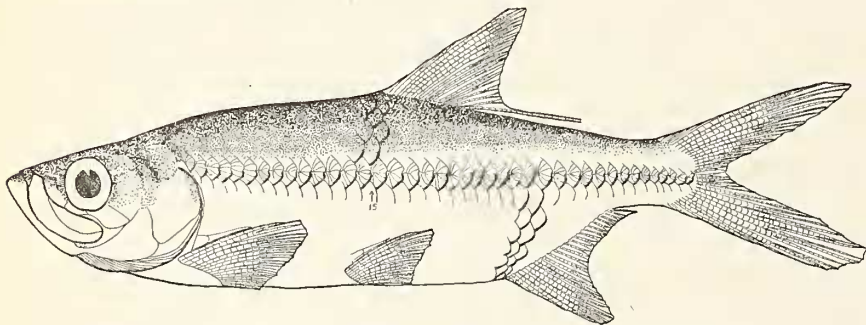
The 28 mm. fish resembles the adult in appearance and shape. The mid-line pigment spots are absent but there is dense pigmentation above the lateral line which is also present in the 300 mm. specimen. The accurate Text-fig. 8 of the 28 mm. fish shows the pigment over the whole body. Scales are present which are very thin and absorb no bone stain. In a larger



Text-figure 8.

Megalops cyprinoides. This 28 mm. specimen resembles in general the adult in appearance and shape. Delicate scales are present which absorb no bone stain. ($\times 3.2$).

specimen of 34 mm. the scales take a light stain. Myomeres cannot be counted but the distance between the head and the anterior of the dorsal is relatively shorter than in the 16.5 mm. fish. This is also true of the distance between the ventrals and the anal fins. The paired fins are proportionately larger than those of the 16.5 mm. specimen. The ventrals are in a central position. The median fins have also increased proportionately. The dorsal fin is more anterior in position than in the 16.5 mm. fish and, in cleared specimens, the anterior margin of the dorsal is almost directly opposite the base of the ventral fins. This is true in our 26 mm. cleared specimen and of all specimens larger and older.

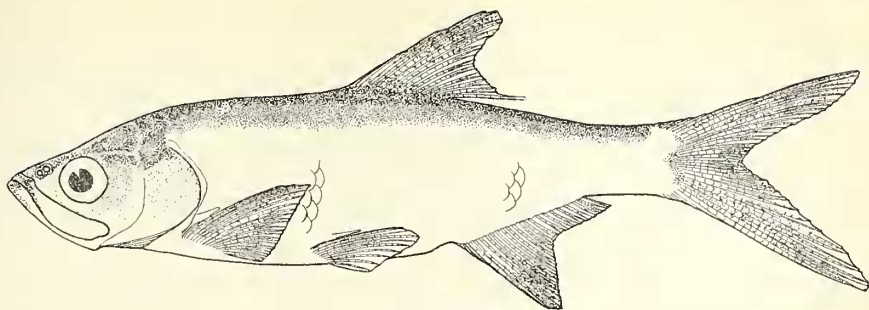


Text-figure 9.

Megalops cyprinoides. The 300 mm. specimen represents the adult form including secondary growth characters as the prolonged dorsal ray, axillary scales and well developed body scales. The marked 15th scale of the lateral line is enlarged in Text-figure 12. ($\times 1/3$).

The 300 mm. *Megalops* has more pigmentation than smaller specimens as shown in Text-fig. 9. The scales are well developed and take a deep stain for bone. The 15th scale of the lateral line is shown in Text-fig. 12. The position of the fins is the same as in the 28 mm. specimen. The dorsal has developed the prolonged posterior ray, the growth of which is considered later. The axillary scales are also well developed.

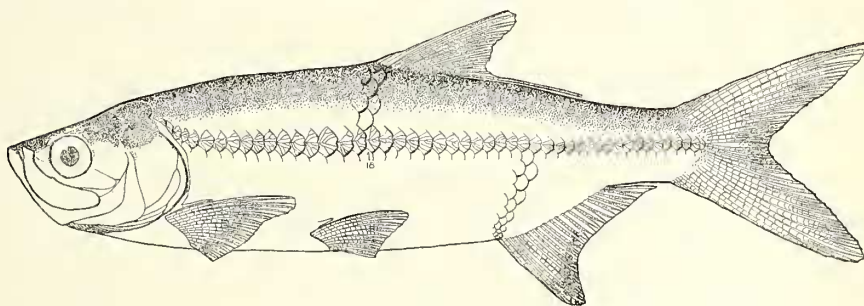
This series of specimens shows that the leptcephali *Megalops* shrink from 24 mm. to 15 mm. At this time the number of post-anal myomeres increases from 19 to 22. Also the myomeres from the head to the dorsal decrease from 45 to 40 and those from the head to the ventrals 27 to 23. The



Text-figure 10.

Tarpon atlanticus. The 78 mm. specimen is comparable with the 51 mm. fish which is the smallest *Tarpon* available for study at the time of writing. As compared to the 238 mm. fish the pigmentation is not as dense and the prolonged dorsal ray not as long as shown in Text-figure 11. The ventrals appear nearer the snout than the ventrals of *Megalops* as shown in Text-figures 8 and 9. ($\times 1.15$).

myomeres from the head to the anal decrease from 48 to 44. Then the larval fish grows longer and begins to resemble the adult. The 16.5 mm. specimen has characters of the younger and older stages. This stage has a decrease of myomeres from the head to the dorsal fin of 40 to 33. The greatest shrinking occurs between the ventral and dorsal fins. In the 24 mm. young the number of caudal vertebrae is the same as that of older and larger fish, and the entire skeleton is well stained. In the 28 mm. specimen the shape of the body and the position of the fins is identical with older specimens. Other growth characters appear later as the body and axillary scales and the prolonged posterior dorsal ray.



Text-figure 11.

Tarpon atlanticus. The 238 mm. specimen represents the adult form including secondary growth characters as the prolonged dorsal ray, axillary scales and well developed body scales. The marked 18th scale of the lateral line is enlarged in Text-figure 13. ($\times 3/8$).

In examining 22 *Megalops cyprinoides* in the collection of the United States National Museum which ranged from 34 mm. to 400 mm. it was found that the prolonged end of the posterior ray of the dorsal fin is only slightly elongated in specimens less than 56 mm. In seven fish the distance that the prolonged ray extends, beyond the margin of the rays immediately above, is 3 mm. in a 56 mm. fish; 10 mm. in an 82 mm. fish; 20 mm. in a 110 mm. fish; 30 mm. in a 140 mm. and a 145 mm. fish; 40 mm. in a 160 mm. fish; 50 mm. in a 210 mm. fish.

In 6 *Tarpon atlanticus* the posterior dorsal ray extends beyond the margin of the rays immediately above as follows; 2 mm. in a 59 mm. fish; 10 mm. in a 115 mm. fish; 15 mm. in a 120 mm. fish; 18 mm. in a 125 mm. fish; 30 mm. in a 170 mm. fish. In a 238 mm. specimen the ray extends 35 mm. but is broken at this length.

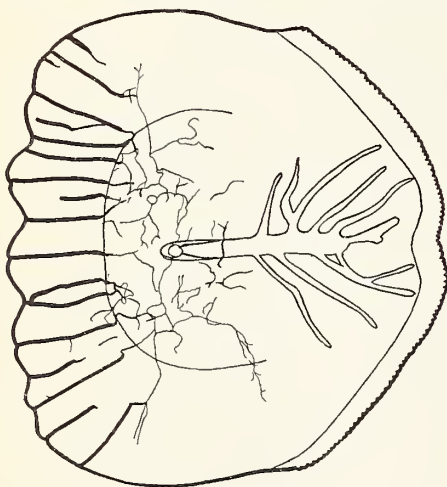
It has already been mentioned in the Taxonomic Discussion that the ventral fins of *Tarpon* are nearer the head than are the ventral fins of *Megalops*. This is shown in the comparative outline drawings of the two species by the lines lettered C. But the distances shown by the lines lettered A and B are the same in *Megalops* and *Tarpon*, and indicate the positions of the dorsal fins (Text-fig. 1).

In addition to these external measurements, it is found in cleared and bone stained specimens of *Megalops* that the anterior margin of the dorsal fin is above the 31st trunk vertebra in a 20 mm. specimen, and above the 29th vertebra in a 24 mm. specimen. In specimens 26 mm., 34 mm., and 56 mm., it is above the 27th trunk vertebra. The relative positions of the fins are constant in *Megalops* of approximately 26 mm. and larger (Text-figs. 8, 9). The ventral fins are also in line with trunk vertebra number 27 and therefore opposite the anterior of the dorsal fin.

In cleared and stained *Tarpon*, 51 mm., 55 mm., and 59 mm., the anterior margin of the dorsal fin is above the 27th trunk vertebra, which is the same as in *Megalops*. But the ventral fins are in line with the 22nd vertebra, which is anterior by five vertebrae than in *Megalops*. The ventral fins are nearer the head in all these specimens which is seen in detail in Text-figs. 10, 11.

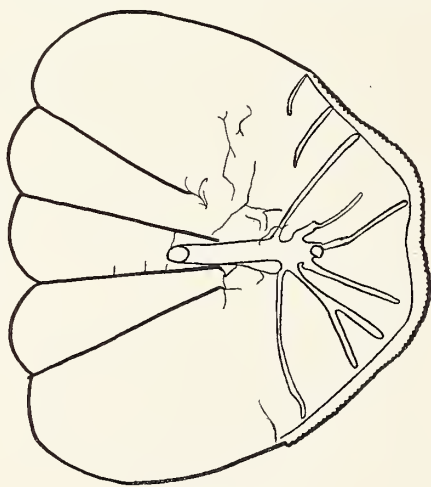
Scales.

Two lateral line scales taken from below the anterior margin of the dorsal fin of *Megalops* and *Tarpon* show differences in the two species. In *Megalops* this was the 15th scale (Text-fig. 12) and in *Tarpon* the 18th



Text-figure 12.

Scale of 300 mm. *Megalops cyprinoides* which is the 15th in the lateral line and taken from below the anterior margin of the dorsal fin as marked in Text-figure 9. ($\times 3.7$).



Text-figure 13.

Scale of 238 mm. *Tarpon atlanticus* which is the 18th scale in the lateral line and taken from below the anterior margin of the dorsal fin as marked in Text-figure 11. ($\times 4.3$).

(Text-fig. 13). In order to bring out variations in the two species all concentric lines have been omitted. The shape of the *Megalops* scale is rounder than the *Tarpon* scale and the former has many marginal scallops and lines radiating inward for a short distance. The *Tarpon* scale has only three marginal scallops with four lines radiating toward the center. These lines are much longer than in *Megalops*. The illustrations show that the architecture of the *Megalops* scale is more complex than the scale of *Tarpon*.

KEY TO CAUDAL FIN OF *Megalops* AND *Tarpon*.

(Text-figs. 14, 15).

- A. Position of the first or anterior pair of uroneurals: anterior end arises on centrum which is fourth from last and precedes centrum with reduced neural process.

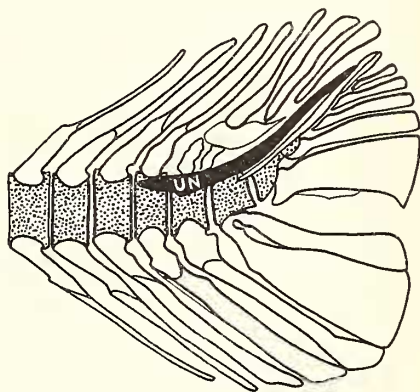
Caudal vertebrae: 30. Total vertebrae 68: 38 trunk plus 30 caudal.

Caudal ray count: total 35 or 34. Dorsal 18, ventral 17 or 16.

Text-fig. 14.

Megalops cyprinoides.

C=30



- B. Position of first or anterior pair of uroneurals: anterior end arises on centrum which is third from last and has reduced neural process.

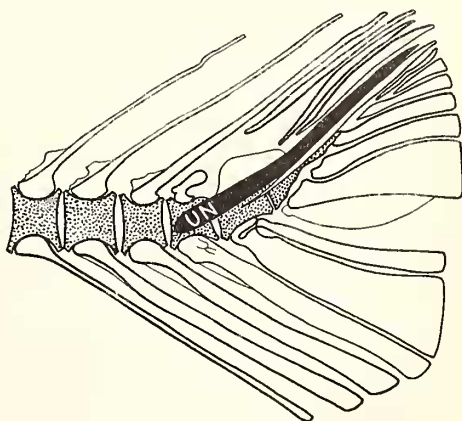
Caudal vertebrae: 24. Total vertebrae 57: 33 trunk plus 24 caudal.

Caudal ray count: total 31 or 30. Dorsal 17 or 16, ventral 15 or 14.

Text-fig. 15.

Tarpon atlanticus.

C=24



CAUDAL SKELETON OF *Megalops cyprinoides*, INCLUDING
A COMPARISON WITH *Tarpon atlanticus*.

(Text-figs. 16-21).

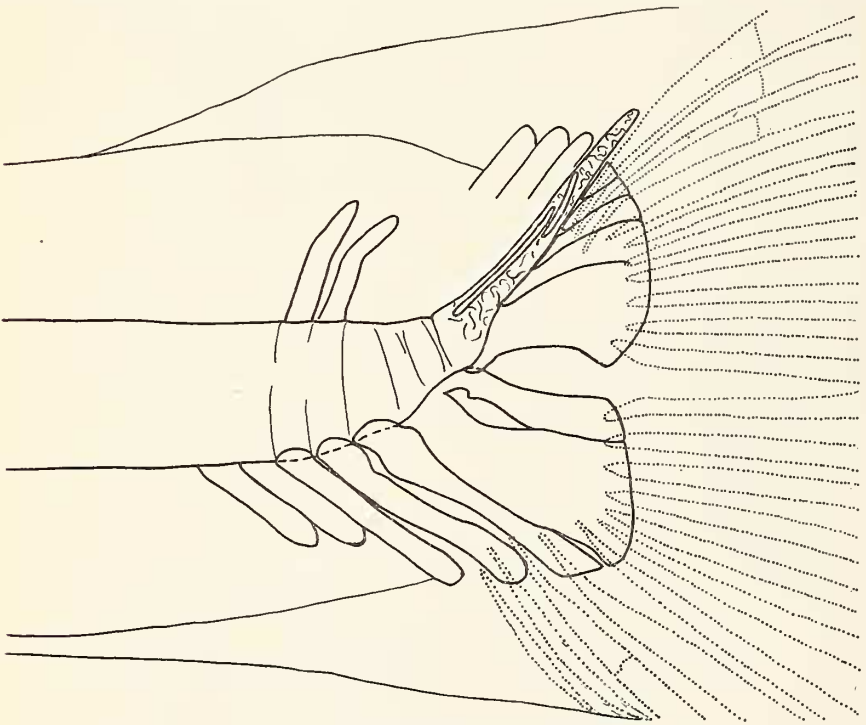
Material Studied.

7 *Megalops* in the leptocephalus phase, 24 mm. to 22 mm., Cat. No. 28,903. Also 2 specimens, 22 mm. and 16.5 mm., KOH Cat. No. 2,288. 4 young fish, 20 mm., 24 mm., 26 mm., and 34 mm., KOH Cat. No. 2,288 and 2,295. 1 specimen, 55 mm., U. S. Nat. Mus., KOH Cat. No. 2,301. The specimens with the KOH numbers have been cleared and stained.

3 *Tarpon*, 51 mm., 55 mm., and 59 mm., KOH Cat. No. 2,302. In addition, specimens described in Hollister, 1936.2, pages 263 to 268. The drawing of the 140 mm. specimen is reprinted for comparison with *Megalops*.

Caudal Osteology.

Ossification: In the 22 mm. and 16.5 mm. leptocephalus specimens there is no ossification but in the 20 mm. transitional specimen there is partial ossification of the column and other bones. The centra are thin, imperfect, bony rings which give rise to well ossified vertebrae of the older fish. Text-figs. 16, 17, show the column is continuous in these stages but Text-fig. 20



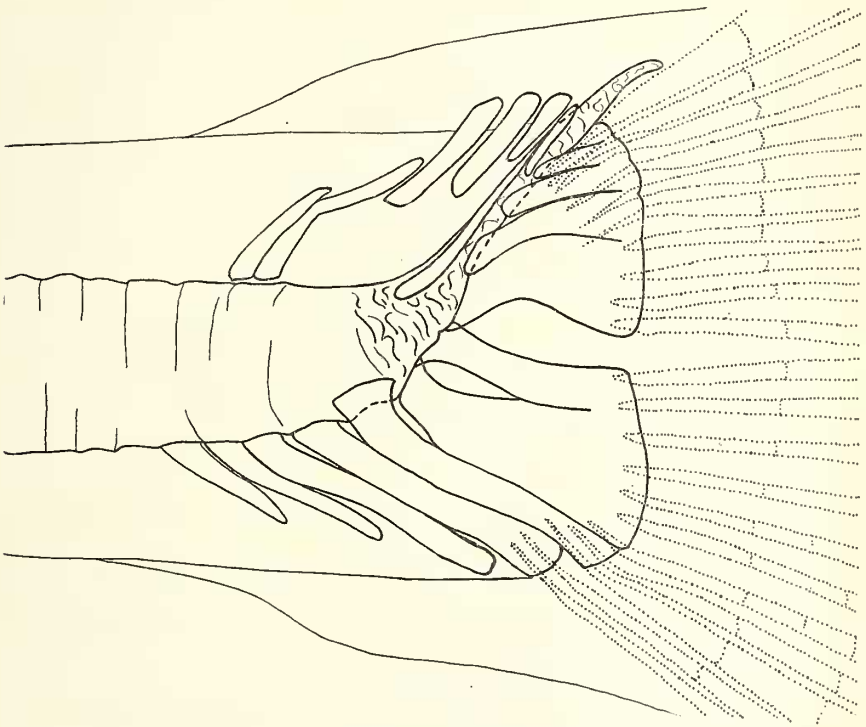
Text-figure 16.

Megalops cyprinoides. Tail of 22 mm. leptocephalus specimen which is unossified and the column unsegmented. The anterior and second pair of uroneurals are slender bones on the sides of the upturned distal end of the notochord. The illustration of the total fish in Text-figure 5 of a 21 mm. specimen shows the external form. ($\times 37$).

shows the column is segmented in the 34 mm. fish. There is considerable increase in ossification in the 26 mm. specimen and also in the 34 mm. fish which resembles older stages. It has also been found in the young of other species that ossification appears suddenly at a youthful stage and develops rapidly.

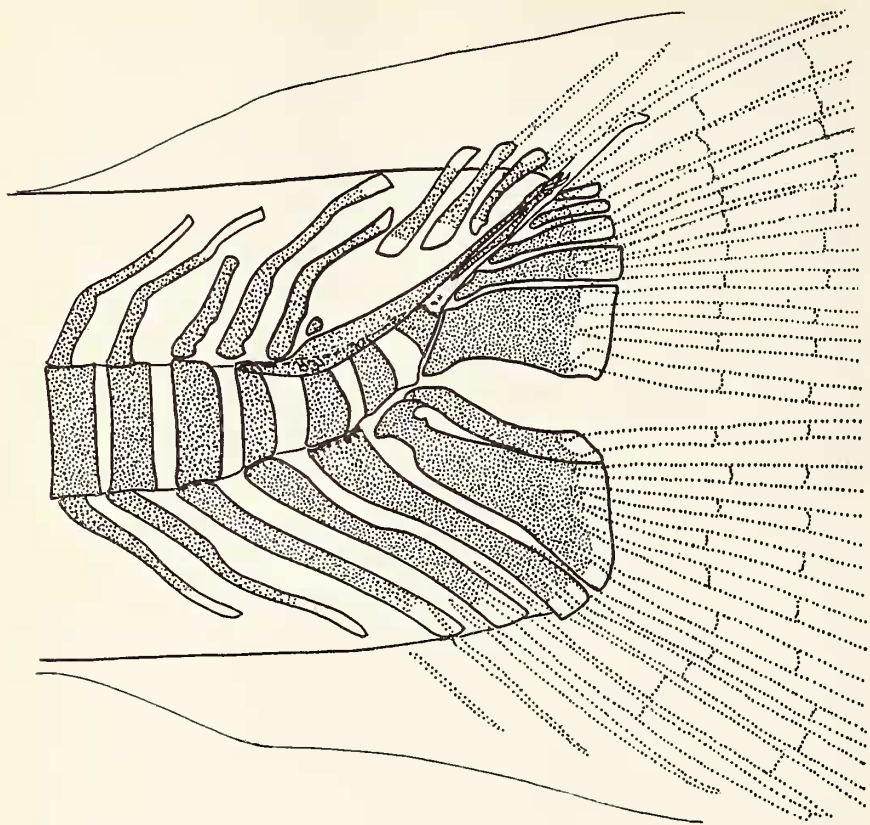
Urostyle: In the two larval specimens, 22 mm. and 16.5 mm., the urostyle has no definite segmentation and the cartilaginous notochord extends dorsally beyond the distal margin of the hypurals and the epurals (Text-figs. 16 & 17). In the 20 mm. transitional specimen, where partial ossification is present, three narrow centra form the urostyle (Text-fig. 18). In the 26 mm. and 34 mm. specimens the posterior terminal centrum is elongate and narrows distally to a rod-like end (Text-figs. 19 & 20). It is also seen in the Text-fig. 21 of *Tarpon atlanticus* that two complete centra and one elongate centrum form the urostyle.

Uroneurals: There are three pairs of uroneurals in the adult *Megalops* (Text-fig. 20). This is also true in *Tarpon* (Text-fig. 21). In the unossified 22 mm. *Megalops* only two uroneurals can be detected. These are slender bones lying on the sides of the notochord (Text-fig. 16). In the 16.5 mm. unossified specimen both pairs of the uroneurals have grown longer (Text-fig. 17). In the partially ossified 20 mm. specimen the two pairs of uroneurals are considerably longer than those of the 16.5 mm. specimen. In addition, the



Text-figure 17.

Megalops cyprinoides. Tail of 16.5 mm. fish which is unossified. There is indication of later segmentation of the column by the incomplete vertical lines. The uroneurals are larger and the bones of the anterior pair longer than those of the 22 mm. fish. The illustration of the total fish in Text-figure 7 shows the external form which has changed more than the internal caudal structure. ($\times 40$).



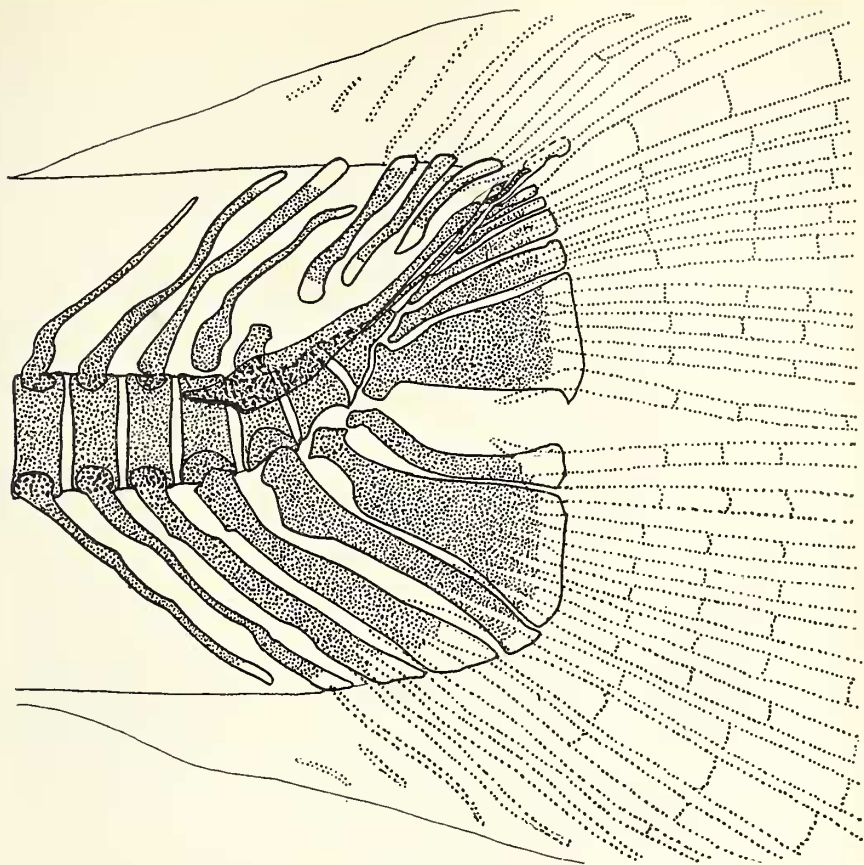
Text-figure 18.

Megalops cyprinoides. Tail of 20 mm. fish with considerable ossification but the column unsegmented. The anterior uroneural bones have lengthened considerably and the anterior tips appear on the same centrum as in all older stages. The diminutive third pair of uroneurals is present. The neurals are irregular in this specimen. ($\times 34$).

third pair of uroneurals is present. These bones are very small and cross obliquely the distal tips of the other uroneurals. The third diminutive pair of uroneurals is elongated slightly in the 26 mm. and 34 mm. fish (Text-figs. 19 & 20).

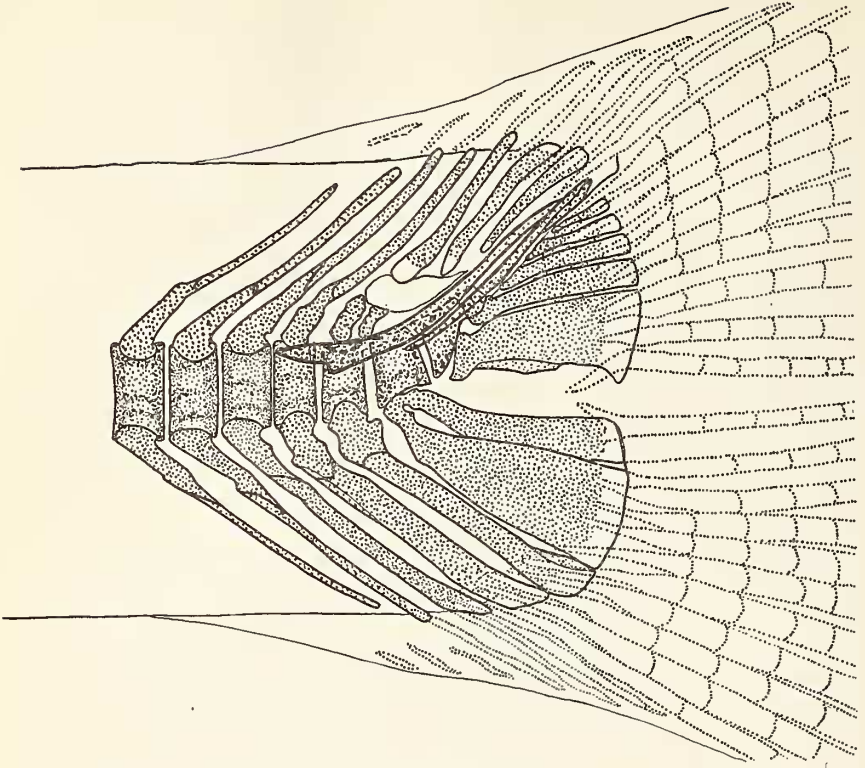
Hypurals: There are eight hypurals on the urostyle, three below and five above the median line (Text-fig. 20). This is also true in *Tarpon*, as shown in Text-fig. 21. Three additional long haemal spines project into the caudal contour with fin rays attached in *Megalops* and *Tarpon*. As in *Tarpon*, *Megalops* has two hypurals adjacent to a single urostyle centrum. In the 20 mm. and 26 mm. specimens the basal ends of the two hypurals are separate, although closely associated (Text-figs. 18 & 19). In the 34 mm. fish the basal ends appear as one (Text-fig. 20). This is true in the 51 mm. *Tarpon* and also in the 140 mm. fish (Text-fig. 21). This development takes place between the ages of 26 mm. and 34 mm. in *Megalops* (Text-figs. 19 & 20).

Epurals: There are three epurals present in all growth stages of *Megalops*. This is true of *Tarpon*. These bones are the last to ossify (Text-figs. 20 & 21).



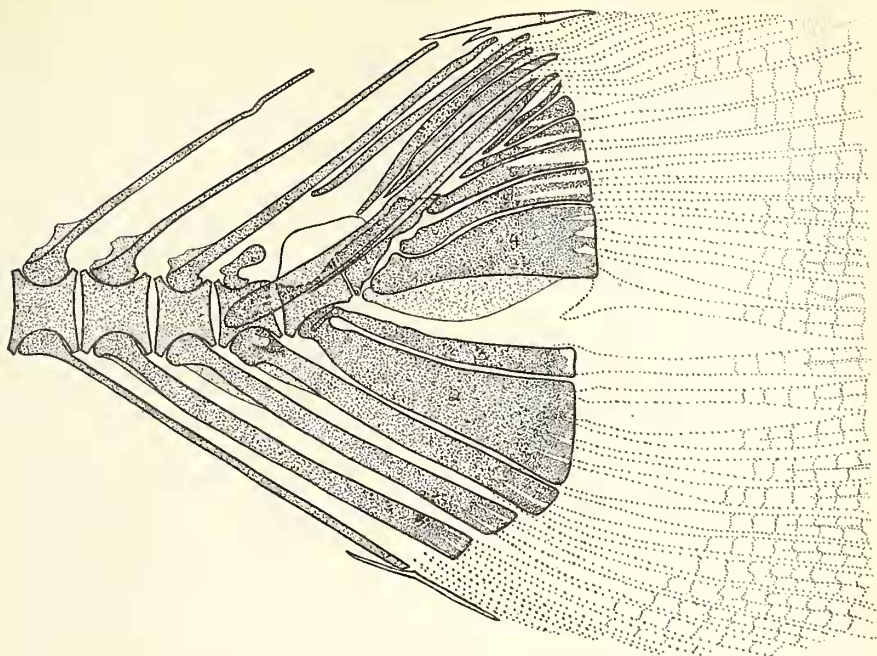
Text-figure 19.

Megalops cyprinoides. Tail of 26 mm. fish showing considerable increase in ossification but the column still unsegmented. The bones of the second pair of uroneurals have lengthened. For external development see Text-figure 8 of a 28 mm. specimen. ($\times 15$).



Text-figure 20.

Megalops cyprinoides. Tail of 34 mm. specimen which has general increase in ossification and the column segmented. The bones of the second pair of uroneurals have lengthened anteriorly and the tips are on the same centrum as in older fish. The cartilage plate is present between the urostyle and the epurals. This is present also in the 51 mm. *Tarpon* and shown in Text-figure 21. The double reduced neurals are irregular. ($\times 18.6$).



Text-figure 21.

Tarpon atlanticus. Tail of 140 mm. specimen reproduced for comparison with the caudal of *Megalops*. The tail structure of the 140 mm. fish is similar to that of the 51 mm. *Tarpon*. ($\times 4.75$).

Caudal Fin Ray Count:

Megalops:

22 mm. fish.	10/11, 21.	No ossification. (Text-fig. 16).
16.5 mm. fish.	10/12, 22.	No ossification. (Text-fig. 17).
20 mm. fish.	13/13, 26.	Partial Ossification. (Text-fig. 18).
26 mm. fish.	18/16, 34.	Ossification. (Text-fig. 19).
34 mm. fish.	18/17, 35.	Ossification. (Text-fig. 20).
56 mm. fish.	18/16, 34.	Ossification.

Tarpon:

55 mm.	{	16/15, 31.	Ossification.
59 mm. fish.			
115 mm.	{	16/14 or 15, 30 or 31.	Ossification. (Text-fig. 21).
120 mm. fish.			
140 mm.			

Specialized Ray-scales: There are no specialized ray-scales in *Megalops*. But *Tarpon* has well developed dorsal and ventral ray-scales as shown in Text-fig. 21. Regan (1910) made the following note: "In *Elops*, but not in *Megalops*, there is an oblong ray-scale above and below, partly covering the first upper and lower rays."

ANNOTATED BIBLIOGRAPHY OF *Megalops* AND *Tarpon*.

In choosing authors for the bibliography an attempt has been made to bring together only references of importance pertaining to both the Pacific and Atlantic species. In most cases these are annotated. The subjects include the original and earliest authors, references to extreme geographical ranges where *Tarpon* have been reported, references concerning the osteology and anatomy of both species, and those describing *Tarpon* nurseries and very small *Tarpon*. The angler's interest has also been remembered. These references, together with their bibliographies, constitute most of the known literature of this nature on the two species of Megalopidae. The different groupings will be found following the alphabetical annotated list.

BABCOCK, LOUIS L.

1936. *The Tarpon*. Pp. 1-175.

This is one of the most complete accounts of the *Tarpon* published. The fourth edition was privately printed in 1936. Good summary of literature and accounts of young *Tarpon*.

BARNARD, K. H.

1925. *Annals of the South African Museum*. Vol. XXI, Part I, containing a Monograph of the Marine Fishes of South Africa. June, 1925, pp. 1-418. Geographical reference for *Megalops* found on Natal coast, pp. 104-105.

BEAN, TARLETON H.

1906. A Catalogue of the Fishes of Bermuda, with notes on a collection made in 1905 for the Field Museum. *Field Columbian Museum*. Vol. VII, No. 2, July, 1906, pp. 21-89.
Tarpon listed on p. 33.

BEAUFORT, L. F. DE.

1909. *Die Schwimmblase der Malacopterygier*. Gegenbaurs Morphologisches Jahrbuch. Leipzig, 1909, pp. 526-644. Figures and Plate.
Observed that *Megalops cyprinoides* regularly rises to the surface for air.

BEEBE, WILLIAM.

1927. A *Tarpon* Nursery in Haiti. *New York Zoological Society Bulletin*, Vol. XXX, No. 5, Sept.-Oct., 1927, pp. 141-145.
1928. *Beneath Tropic Seas*. G. P. Putnam's Sons, New York-London, The Knickerbocker Press, 1928.
Translation of Van Kampen's original description of larva of *Megalops cyprinoides*, with illustration, pp. 228-229.

BEEBE, WILLIAM & HOLLISTER, GLORIA.

- 1935.1. The Fishes of Union Island, Grenadines and British West Indies, with a description of a new species of star-gazer. *Zoologica*, XIX, No. 6, p. 211.
Four *Tarpon* seen in twenty-five feet of water near shore off Medusa Islet, July 6, 1932, and on several other days. Only visible when below in diving helmet. Quite fearless, passing within ten feet, and all about the same size, six feet in length. Our expert tarpon fishermen could not persuade them to rise to any bait or lure.

BEEBE, WILLIAM & TEE-VAN, JOHN.

1928. The Fishes of Port-Au-Prince Bay, Haiti. *Zoologica*, Vol. X, No. 1, December 31, 1928, pp. 33-36.
Three-inch *Tarpon* taken in mid-January at Source Matelas, 15 miles from Port-au-Prince.
1933. *Field Book of the Shore Fishes of Bermuda*. G. P. Putnam's Sons, New York-London, 1933, pp. 33-34.
Several four-foot fish have been seen when diving near Gurnet Rock.

BIGELOW, HENRY B. & WELSH, WILLIAM W.

1924. Fishes of the Gulf of Maine. *Bulletin of the United States Bureau of Fisheries*, Vol. XL, Part I, 1924, p. 91.

Reference to two northern records, see Halkett & Radcliffe. *Tarpon* rare in Gulf of Maine.

BREder, C. M., JR.

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9 *Tarpon*, 7% to 13% inches, Andros Island, Bahamas. Natives reported many smaller ones.

- 1939.1. On the Trail of the *Tarpon*. *New York Zoological Society Bulletin*, Vol. XLII, No. 4, July-August, 1939, pp. 99-110.

The establishing of the New York Aquarium's laboratory on Palmetto Key, west coast of Florida. Many *Tarpon* of 3 or more inches reported in Peace and Myakka Rivers and the Ten Thousand Islands, Florida.

- 1939.2. The Tiniest of *Tarpon* now at the Aquarium. Forty-six specimens caught in Florida range down to only a little more than two inches in length—found in a newly-formed pool. *New York Zoological Society Bulletin*, Vol. XLII, No. 5, September-October, 1939, pp. 154-155.

An account of 48 tiny *Tarpon* from Florida. The smallest measured 2% and 2% inches total length, "and some even slightly smaller."

BROUSSONET, P. M. AUGUSTI.

1782. *Ichthyologia Sistens Piscium Descriptiones et Icones*. December 1, 1782. Includes four pages of description in Latin and full page plate of *Chupea cyprinoides*.

COKER, R. E.

1921. A Record of Young *Tarpon*. *Copeia*, No. 93, April 25, 1921, pp. 25-26. 7 *Tarpon*, 6 to 10 inches, taken November 19, 1920, in Dauphin Bay, Gulf of Mexico.

CUVIER, M. LE B. & VALENCIENNES, M. A.

1846. *Hist. Nat. Poiss.*, Vol. XIX, 1846, pp. 383-401. Description des *Mégaloques*.

Megalops, Commerson, pp. 383-388. Description Le *Mégaloque Indien*, *Megalops indicus*, nob., with colored plate, pp. 388-398. Description of type of Atlantic species, *Megalops atlanticus*, pp. 398-401. Type localities, Guadeloupe, Santo Domingo, Martinique and Porto Rico.

DAY, FRANCIS.

1878. The Fishes of India, being a Natural History of the Fishes known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Text, Vol. I, pp. -XX and 1-816. Published by Bernard Quaritch, London, 1878.

Megalops treated on pp. 650 and 651. References to *Megalops* Commerson, and synopsis of individual species. "Habitat:—East Coast of Africa, fresh waters and estuaries of India, Ceylon, Malay Archipelago, China, and Polynesia. It is occasionally captured in rivers, but much more commonly found in tanks."

DELSMAN, H. C.

1926. Fish Eggs and Larvae from the Java Sea. *Treubia*, Batavia, Vol. 8, 1926, pp. 389-412.

Vertebral counts of *Megalops* larvae on p. 408.

DELSMAN, H. C. & HARDENBERG, J. D. F.

1934. De Indische Zeevisschen en Zeevisscheriz. 1934, p. 117, fig. 73.

Excellent plate of *Megalops cyprinoides*. "*Megalops cyprinoides* regularly rises to the surface for a snatch of air."

EIGENMANN, C. H.

1904. The Fresh-Water Fishes of Western Cuba. *Bulletin U. S. Fish Comm. for 1902*. Vol. XXII, p. 222.

One of smallest recorded *Tarpon*, 20 mm., no description. Fish cannot be located. Also three others, 119, 182 and 192 mm., taken with the 20 mm. fish in March, 1902, in a deep pool, many miles from the sea—Pinar del Rio, Western Cuba.

1912. The Freshwater Fishes of British Guiana. Including a Study of the Ecological Grouping of Species and the Relation of the Fauna of the Plateau to that of the Lowlands. *Memoirs of the Carnegie Museum*, Vol. V, Serial No. 67, June, 1912, p. 444.

One of southernmost records. One specimen, Georgetown Market, Carnegie Museum Cat. No. 2427. See also Muller & Troschel, mentioned in this reference.

EVERMANN, B. W. & MARSH, M. C.

1902. The Fishes of Porto Rico. *Bulletin U. S. Fish Comm. for 1900*. Vol. XX, Part I, pp. 79-80, figure.

13 *Tarpon*, 2.25 to 3.25 inches. Taken in a small brackish pool, corner of mangrove swamp, separated from the sea, in February, 1900.

FOWLER, H. W.

1933. Notes on Louisiana Fishes. *Proc. Biol. Soc. Wash.*, Vol. 46, p. 58.

Megalops atlanticus Valenciennes. Lake Charles. Several exceeding 610 mm. taken during the past few years. May be seen most any morning feeding on mullet.

1936. The Marine Fishes of West Africa. Based on the collection of the American Museum Congo Expedition, 1909-1915. *Bull. Amer. Mus. Nat. Hist.*, Vol. LXX, Part I, pp. VII & 1-605, January, 1936.

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GILL, T.

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A single skin was seen in the collection of John T. Bartram of St. George, Bermuda.

GREGORY, WILLIAM K.

1933. Fish Skulls: A Study of the Evolution of Natural Mechanisms. *Transactions of The American Philosophical Society*, Vol. XXIII, Article II, 1933.

Tarpon dealt with on pp. 139-141.

HALKETT, ANDREW.

1913. Check list of the fishes of the Dominion of Canada and Newfoundland. Ottawa, pp. 1-138, pls. I-XIV, 1913.

Specimen speared in eel-grass at Harrigan Cove, Nova Scotia, Sept. 6, 1906, and is in the Provincial Museum, Halifax. *Tarpon* dealt with on p. 43. One of northernmost records.

HARGREAVES, T. SIDNEY.

1904. The Fishes of British Guiana. Demerara: "The Argosy" Company, limited. 1904, pp. 1-36.

Tarpon dealt with on pp. 4-6. Many adults caught and seen. Geographical reference states range to "Western Brazil."

HEILNER, VAN CAMPEN.

1937. Salt Water Fishing. The Penn Publishing Company, Philadelphia. Pages 1-452.

Excellent study of *Tarpon* from the sportsman's angle.

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Description of the 20 mm. *Tarpon* mentioned by Storey & Perry, which includes differences between *Tarpon* and *Albula*. Only known specimen of transitional *Tarpon* and one of smallest recorded. Taken at Core Creek, from very brackish water. Fish accidentally destroyed.

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HOLLISTER, GLORIA.

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- 1936.1. A Fish which Grows by Shrinking. *New York Zoological Society Bulletin*, Vol. XXXIX, No. 3, May-June, 1936, pp. 104-109.

An account of transformation from *leptocephalus* to young of *Albula vulpes*, an isospondylid.

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Tarpon dealt with on pp. 263-268. Complete caudal skeleton bibliography. Also mentions *Tarpon* seen while helmet-diving.

HOLSTVOOGD, C.

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JORDAN, D. S. & EVERMANN, B. W.

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Leptocephalus larva of *Megalops cyprinoides* first recognized by Kampen in 1908. Translation in "Beneath Tropic Seas," Beebe, 1928.

LACÉPÈDE, B. G. E. DE LA V. (COUNT).

1803. Lacépède's *Hist. Nat. d. Poissons*, Vol. V, 1803, p. 289.

Found in Buffon (G.L.L. De) *Count. Hist. Nat. avec la description du Cabinet du Roi*, 44 Tom. illust. Paris, 1749-1804. One of earliest authors to describe *Megalops*. See Cuvier & Valenciennes, p. 385.

MACPHERSON, G. A. HILL.

1935. A Record Tarpon from Nigeria. *The Field*, Vol. CLXV, No. 4288. The Field Press, London, England, March 2, 1935, p. 447.

A 156-pound *Tarpon* caught by Mr. J. N. Zarpas in Lagos Harbour, Nigeria. Good photograph which shows position of fins.

MARCGRAVIUS, GEORGIUS.

1648. *Historiae rerum Naturalim Brasiliae*. Lib. IV, *Hist. Piscium*, page 179. Published at Leyden, and Amsterdam.

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MEEK, ALEXANDER.

1916. *The Migrations of Fish*. London, published by Edward Arnold, 1916, pp. -XVIII and 1-427.

The spawning habits of *Elopidae* on pp. 64-65.

MEEK, S. E. & HILDEBRAND, S. F.

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Five specimens, 300 to 575 mm., preserved, caught at Gatun, Mindi and Colon.

MONOD, THEODORE

1927. *Faune des Colonies Francaises*, by Gruvel, A. Pages 643-742 = Contribution a La Faune Du Cameroun.

Page 654 = *Megalops* note: "Espèce non encore signalée au Cameroun. Ce poisson qui peut atteindre des tailles énormes est rare mais se rencontre cependant dans tout la région. Je l'ai observé personnellement à Souelaba et à Kribi. Les écailles si développées de cette espèce obtiendraient des fabricants de fleurs artificielles des prix intéressants. Malheureusement le Tarpon est trop rare pour que ce produit puisse être récolté au Cameroun."

Megalops found at Souelaba and Kribi, Cameroon.

MULLER, JOHANNES & TROSCHER, FRANZ HERMANN.

1848. *Reisen in British-Guiana in den Jahren 1840-1844*. Im Auftrag Sr. Majestat des Königs von Preussen Ausgeführt von Richard Schomburgk. *Fische*, Vol. III, 1848, pp. 618-644.

One of southernmost records. The following is the complete reference found on p. 639: *Megalops* Commerson "Dieser Seefisch Kommt an der ganzen Küste vor und erreicht die Länge von 2 Fuss; sein Fleisch ist essbar. Schomb."

NICHOLS, J. T.

1929. *The Fishes of Porto Rico and the Virgin Islands*. *Scientific Survey of Porto Rico and the Virgin Islands*, *New York Academy of Sciences*, Vol. X, Part 2, 1929, pp. 161-535.

Tarpon dealt with on pp. 198-199. Gives size and number of eggs, unripe, in 142-lb. female.

PELLEGRIN, JACQUES.

1923. Les poissons des eaux douces de l'Afrique occidentale (du Sénégal au Niger). Gouv. Gén. l'Afrique Occ. Française Pub. Com. d'Etudes Hist. Sci. Paris, 1923, pp. 1-373.

Page 44. *Megalops* found at the mouth of the Senegal and Congo.

RADCLIFFE, LEWIS.

1916. An Extension of the Recorded Range of Three Species of Fishes in New England Waters. *Copeia*, No. 26, January 24, 1916, pp. 2-3.

One of northernmost records, Provincetown, Mass.

REGAN, C. T.

1909. A Revision of the Fishes of the genus *Elops*. *Ann. Mag. Nat. Hist.*, Vol. III, 8 ser., 1909, pp. 37-40.

1910. The Caudal Fin of the Elopidae and some other Teleostean Fishes. *Ann. Mag. Nat. Hist.*, Vol. V, 8 ser., 1910, pp. 354-358, 2 figs.

Good drawings of the caudal rays of *Megalops cyprinoides* and *Tarpon atlanticus*.

RIDGEWOOD, W. G.

1904. On the Cranial Osteology of the Fishes of the Families Elopidae and Albulidae, with Remarks on the Morphology of the skull in the Lower Teleostean Fishes generally. *Proc. Zool. Soc. London*, 1904, Vol. II, pp. 35-81.

Includes many references to cranial osteology.

ROUGHLEY, T. C.

1916. Fishes of Australia and their Technology. Technical Education Series, No. 21. Technological Museum, Sydney, 1916, pp. -XVI, 1-296.

Megalops, pp. 11-12, plate I. Geographical reference and said to rank high in food value.

SENIOR, H. D.

- 1907.1. The Conus Arteriosus in *Tarpon atlanticus* (Cuvier & Valenciennes). *Biol. Bull. Woods Hole*, 1907, 12, pp. 146-151, 3 figs.

- 1907.2. Note on the Conus Arteriosus of *Megalops cyprinoides* (Broussonet). *Biol. Bull. Woods Hole*, 1907, 12, pp. 378-379, 2 figs.

STEAD, DAVID G.

1906. Fishes of Australia. A Popular and Systematic Guide to the Study of the Wealth within our Waters. Sydney; William Brooks & Co., 1906, pp. -XII, 1-278.

Megalops, pp. 23-24. Systematic description.

STOREY, MARGARET & PERRY, LOUISE M.

1933. A Record of Young Tarpon at Sanibel Island, Lee County, Florida. *Science*, Vol. 78, September 29, 1933, pp. 284-285.

Mention of 20 mm. specimen in the Bureau of Fisheries, Washington; erroneously given as 25 mm. See Hildebrand, 1934, for description. Fish accidentally destroyed.

SUNIER, DR. A. L. J.

1921. Contribution to the Knowledge of the Natural History of the Marine Fish-Ponds of Batavia. *Treubia*, Vol. II, pp. 159-405, illustrations.

Tells of very young fish coming in from the sea and swimming against the current, wriggling through the trelliswork partition of the little sluice gates. Among these are found *Megalops cyprinoides*.

WALFORD, LIONEL A.

1937. Marine Game Fishes of the Pacific Coast from Alaska to the Equator. A Contribution from The Santa Barbara Museum of Natural History. University of California Press, Berkeley, 1937, pp. ix-xxix, 1-205, and 147 plates and figures.

Footnote on p. 166. "I have the following note from Walter D. Clark, of the Panama Canal Zone: 'Have definite proof of tarpon now on Pacific side in spillway at Pacific end of Canal. Do not know if they venture into the Pacific Ocean proper or not. Plentiful in the Lake area'."

WEBER, MAX & BEAUFORT, L. F. DE.

1913. The Fishes of the Indo-Australian Archipelago. E. J. Brill, Ltd., Leiden, 1913, Vol. II, pp. -XX, 1-378.

Megalops dealt with on pp. 4-6.

WHITON, HENRY D. & TOWNSEND, CHARLES.

1928. Tarpon Behavior in Calcasieu Pass. *New York Zoological Society Bulletin*, Vol. XXXI, No. 5, Sept.-Oct., 1928, pp. 170-172.

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| Broussonet, P. M. Augusti | 1782. <i>Clupea cyprinoides</i> . |
| Lacépède, B. G. E. de la V. (Count) | 1803. <i>Megalops</i> . |
| Cuvier, M. Le B. & Valenciennes, M. A. | 1846. <i>Megalops atlanticus</i> . |
| Jordan, D. S. & Evermann, B. W. | 1896. <i>Tarpon atlanticus</i> . |

II. Geographical References for Tarpon.

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| Bigelow, Henry B. & Welsh, William W. | 1924. |
| Halkett, Andrew | 1913. |
| Radcliffe, Lewis | 1916. |

Bermuda.

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| Bean, Tarleton H. | 1906. |
| Beebe & Tee-Van. | 1933. |
| Goode, G. Brown | 1876. |
| Hollister, Gloria | 1936. |

Louisiana.

- | | |
|-----------------|--------------|
| Fowler, H. W. | 1933. |
| Hubbs, Dr. Carl | Unpublished. |

Atchafaloya River, 150 miles from sea.

Guatemala.

- | | |
|---|--------------|
| Hubbs, Dr. Carl | Unpublished. |
| Rio de la Pasión, about 300 miles by stream to sea. | Many adults. |

Panama Canal.

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| Hildebrand, S. F. | 1937 & 1939. |
| Walford, Lionel A. | 1937. |
| Whiton, Henry D. | 1928. |

South America.

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| Babcock, Louis L. | 1936. |
| Beebe & Tee-Van. | Unpublished. |
| Kartabo, British Guiana. 1 specimen. | |
| Eigenmann, C. H. | 1912. |
| Hargreaves, T. Sidney | 1904. |
| Hubbs, Dr. Carl | Unpublished. |
| Fortaleza, Ceará, Brazil. 1 specimen, 178 mm., Sept. 18, 1935. | |
| Marcgravius, Georgius | 1648. |

Africa, West Coast.

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| Fowler, Henry W. | 1936. |
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| Monod, Theodore | 1927. |
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Heilner, Van Campen	1937.